Ulnar Collateral Ligament Injury in Overhead Throwers

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ABSTRACT

Objective: This review provides an overview and analysis of the most recent literature concerning ulnar collateral ligament injury in overhead throwing athletes. For the sake of consistency, baseball pitchers will be the primary subject of this review. The importance of identifying risk factors in youth athletes will be discussed. Emphasis is given biomechanical evaluation and current treatment of ulnar collateral ligament injuries. Prevention will be highlighted. It is hypothesized that preventive techniques can be implemented to reduce the number of athletes undergoing Tommy John Surgery. The literature was reviewed in an attempt to demonstrate that hypothesis.

Method: A internet search was performed using PubMed, GoogleScholar, and SPORTDiscus. Additional information was found on internet websites, reference textbooks, and news publications.

Conclusion: Ulnar collateral ligament injury and the resultant reconstructive surgery (Tommy John Surgery) have increased dramatically over the last 30 years. The rise can be attributed to public misconceptions about the Tommy John Surgery, abnormal pitching mechanics, and overuse (particularly in youth athletes). Public education, implementation of pitch counts, exclusion of certain pitches until age appropriate, and correction of biomechanical flaws during delivery will reduce the number of UCL injuries and the surgeries to repair them.

Key Indexing Terms: *Ulnar Collateral Ligament injury/insufficiency, Tommy John Surgery, Pitching Biomechanics*

INTRODUCTION

"Ulnar Collateral Ligament (UCL) insufficiency is a career threatening and sometimes career ending injury commonly demonstrated in overhead throwers such as baseball pitchers.[1]" The excessive forces directed into the medial elbow joint during the overhead throwing motion can sprain and in some cases rupture the ulnar collateral ligament. Compromised integrity of the UCL results in acute pain and gross instability of the elbow. Currently, athletes suffering from UCL damage are commonly advised to undergo surgical repair or reconstruction of the UCL, called Tommy John surgery (TJS). The procedure, "boasts an impressive success rate with 85% of patients returning to pre-injury level of play for at least one year.[2 3] " Unfortunately the high cost, extensive rehabilitation, and lengthy recovery times associated with TJS place quite a burden on the athletes themselves as well as the teams that they play for. However, the occurrence of UCL injury is not limited to professional level players. In a 2008 study, it was found that 58% of high-school baseball pitchers experienced medial elbow pain[7]. Consequently, new research is being conducted to investigate methods of UCL injury prevention, most of which center around implementing pitch counts, limiting certain pitch types in youth pitchers, and correcting biomechanical flaws in a pitcher's delivery.

Recent research has emphasized examination and correcting sequencing flaws in the "kinetic chain" used during the pitching motion. It is widely believed that proper throwing mechanics and use of the "kinetic chain" may enable an athlete to achieve maximum performance with minimum chance of injury. This provides a unique opportunity for non-allopathic physicians, such as chiropractors and physical therapists.

They can now utilize their knowledge of the musculoskeletal system and body mechanics to prevent medial elbow injuries and eliminate some of the risk involved in some of America's most historic and popular sports.

Etiology

The ulnar collateral ligament is a poorly vascularized supporting structure located on the medial aspect of each elbow joint [Figure 1]. It has origins on the medial epicondyle of the humerus and olecranon process of the ulna, converging to insert on the coronoid process of the medial ulna. It consists of three distinct sections: the anterior oblique (AOL), posterior oblique (POL), and transverse bundles.[4] According to Dugas et al, the overhead motion of most baseball pitchers "can generate more than 80 Nm of varus torque on the medial side of the elbow. Others have estimated these forces at the elbow to be as high as 120 Nm[6]. The anterior oblique bundle of the ulnar collateral ligament is the primary contributor for resisting this torque.[5]" UCL sprains occur when there is excessive or repetitive stress placed on the ligament that exceeds its tensile properties leading to deterioration and ultimately failure of the ligament. As Yasui pointed out, "Repetitive stresses can cause attenuation or tearing of the UCL, resulting in UCL insufficiency. This condition causes elbow pain during throwing, as

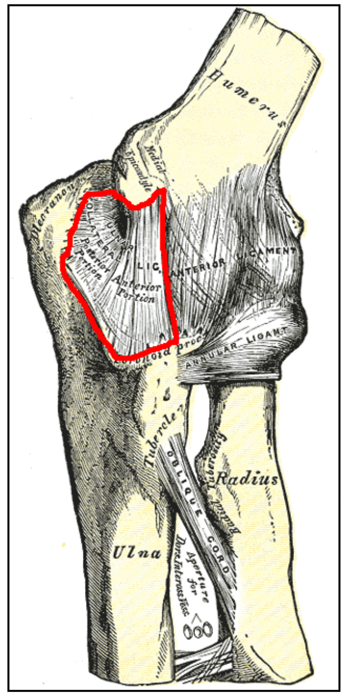

Figure 1 - The Ulnar Collateral Ligament (outlined in red)

well as secondary changes including ulnar nerve symptoms, medial epicondylitis, olecranon osteophytes, osteochondritis dessicans of the capitellum, and loose bodies[6].”

The most common presenting symptom is medial elbow pain, and as previously mentioned, “this can overlap with other pathological conditions. Medial epicondylitis is not uncommon in these athletes[23].” Medial epicondylitis is most commonly associated with involvement of the flexor-pronator mass of muscles which insert onto the medial epicondyle. It is important to note, however, that location of pain is the most distinguishable difference when trying to discern between medial epicondylitis and injury of the UCL.

The repetitive stress and excessive force generated during overhead throwing is often a result of a flaw in pitching mechanics, called an “energy leak.” Efficient throwing mechanics is predicated on a pitcher’s ability to perform a sequence of movements, known as the “kinetic chain.” The kinetic chain principle asserts that in a coordinated human motion, energy, and momentum are transferred through sequential body segments, achieving maximum magnitude in the terminal segment. Fleisig stated that, “While quantifiable differences do exist in proper pitching mechanics for various sports, certain similarities are found in all overhead throwers. One essential property is the utilization of a kinetic chain to generate and transfer energy from the larger body parts to the smaller, more injury-prone upper extremity.[14]” In throwing sports, the kinetic chain starts with the legs progressing to the hips, trunk, upper arm, forearm, and hand, ultimately resulting in the force being applied to the ball as it’s released. When performed in real-time this complex motion is fluid and continuous, however for the sake of analysis it is commonly separated into six distinct phases [Fig. 2]. The phases progress as follows: wind-up, stride, arm cocking, acceleration, deceleration, and follow-through.

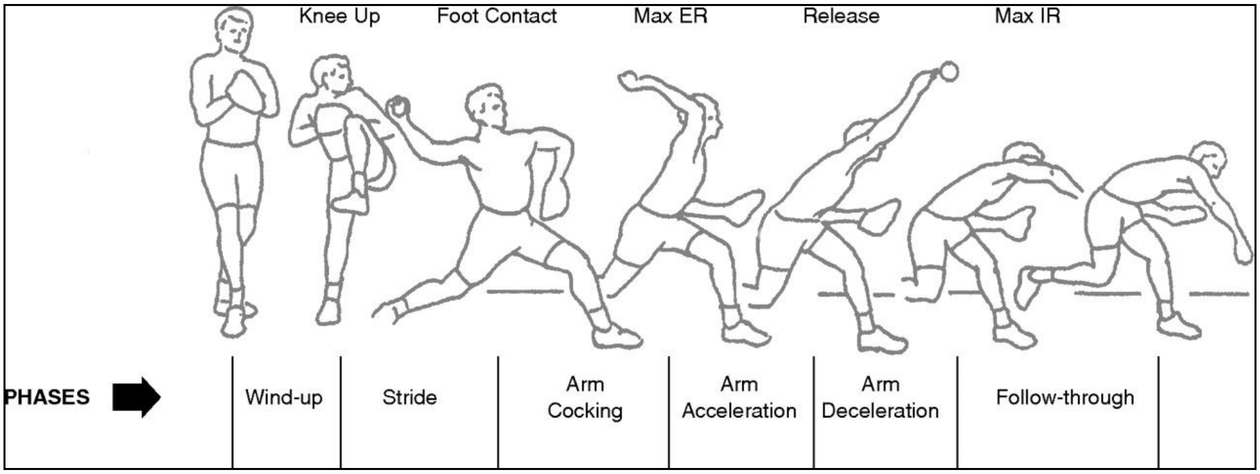

Figure 2 - The phases of pitching

Wind-Up and Stride: The windup and stride phases position the body to optimally generate the forces and power required to achieve top velocity. The windup begins with the initial movement of the contralateral lower extremity, and it culminates with elevation of the lead leg to its highest point and with separation of the throwing hand from the glove[16]. During windup and stride, the pitcher keeps his center of gravity back (over stance leg) for as long as possible to allow maximum generation and transfer of momentum and force to the upper extremity and ball. If the pitcher's body and momentum fall forward prematurely, the kinetic chain will be disrupted and greater shoulder force will be required to propel the ball at top velocity[17].

Cocking: Cocking begins when the hands separate and ends when abduction and maximum lateral rotation of the shoulder is achieved[20]. Cocking is divided into early cocking and late cocking according to the contact of the forward foot on the ground. In early cocking, the scapula is retracted and the humerus is abducted, laterally rotated, and horizontally extended. The elbow flexes and the stride leg begins to extend the knee; abduct, medially rotate and extend the hip; and evert and plantar flex the ankle[21]. The non-throwing shoulder is abducted and its elbow is extending. The body's center of gravity is lowered because the support knee and hip are flexing and the hips and pelvis begin to rotate forward.

Late cocking begins when the stride foot hits the ground[22]. At the time of foot contact, both arms are elevated about 90° and in line with each other along the plane of the shoulders. Anterior stress on the glenohumeral joint is predominant at this time, with the body in front of the arm. When maximum shoulder lateral rotation and abduction to at least 90° occur, the static stabilizers of the shoulder, the glenohumeral capsule and ligaments, serve to limit further motion. Active stabilizers, including the forward flexors, lateral rotators, the subscapularis, pectoralis major, and latissimus dorsi, act as additional restraints to control motion. Scapular stabilizers such as the pectoralis minor and serratus anterior are also active in late cocking. Reciprocal inhibition of the other rotator cuff muscles, the teres minor, supraspinatus, and infraspinatus, is also taking place as these muscles attempt to resist the superior subluxating forces that occur when the trunk is in a forward lean and the shoulder is maximally laterally rotated[22]. At the end of late cocking, the lumbar spine hyperextends to add to the shoulder's lateral rotation[21]. By the end of this phase, the shoulder medial rotators are on maximum stretch, the body is "wound" optimally for the elastic energy transfer, and the pelvis leads the shoulders to face the target legs and trunk begin their acceleration for energy transfer to the arm. Right before the end of this phase, the body laterally tilts to the non-throwing arm side. Shoulder rotation to the target and lateral trunk motion are facilitated by the non-throwing arm's motion from a position of abduction at the start of late cocking to adduction and extension at the end[21].

In a study conducted by The American Sports Medicine Institute, pain with throwing, usually worst in the arm-cocking phase, was the most significant symptom in all patients[11]. Therefore, many health professionals and coaches dedicate most of their injury prevention efforts to the cocking phases of pitching.

<u>Acceleration:</u> "The arm acceleration phase is the explosive portion of the throw between the time of maximum shoulder external rotation and the instant of ball release[24]." The movements in this phase include scapular protraction, humeral horizontal flexion and medial rotation, and elbow extension. Just prior to ball release, the shoulder is still at about 90° of abduction. The glenohumeral joint's capsule is wound tight to provide an elastic force release and the accelerator muscles are also maximally stretched. During this phase the speed of the arm has increased significantly in a relatively brief period, beginning from almost 0°/s at the end of cocking to 7500°/s by the end of acceleration, a time of 50 msec[20]. The serratus anterior and pectoralis major are strongly active during this phase as the arm moves forward and the scapula protracts[22]. The subscapularis and latissimus dorsi are contracting concentrically as the arm moves into medial rotation during acceleration[22].

<u>Deceleration:</u> The arm deceleration phase is the short time from ball release to maximum shoulder internal rotation. The trunk and hips continue to flex and the lead knee and throwing elbow continue to extend until almost full extension is reached[24]. The shoulder continues internal rotation until it reaches approximately 0° and the arm horizontally abducts across the trunk in order to decelerate. "Near the time of ball release, large

compressive forces are produced at both the elbow and shoulder to prevent distraction at these joints[14]. These compressive forces are approximately equal to the bodyweight, which is 2 to 3 times greater than other shoulder and elbow forces generated during throwing. The elbow flexors contract to decelerate elbow extension Elbow extension ends just short of full extension. The wrist and finger extensor muscles also contract eccentrically to decelerate the flexing of the wrist and fingers[24]."

Follow-through: As follow-through proceeds, the body continues to move forward with the arm until motion has ceased. Horizontal adduction increases to 60°, and muscle firing decreases in general. The follow-through phase culminates with the pitcher in a fielding position. The decreased joint loading and minimal forces during this phase render it an unlikely culprit for injury.

Any flaw in timing or incorrect part positioning during this sequence can lead to exaggerated force applied to the next phase of pitching, which frequently results in excess valgus forces and pathology of the medial elbow. Recognition of these flaws is crucial in athletes at all levels of competition, but may be most important in the skeletally immature athletes playing little league and high school baseball.

Epidemiology (prevalence and cost)

In 1974 Frank Jobe performed the first UCL reconstruction on Los Angeles Dodgers pitcher, Tommy John. In the thirty-eight seasons since the pilot procedure, countless pitchers have experienced medial elbow injuries and hundreds of major leaguers have undergone Tommy John surgery. Collectively, major league pitchers recovering from

Tommy John surgery have missed 14,232 regular season games over the last five seasons alone[8]. MLB teams have spent $193,503,317 on their salaries during their recoveries during that five-year span[8]. Since 2001, it has been estimated that 1 in 9 Major League Baseball pitchers has required UCL reconstruction[10]. With an 85% success rate[2 3] and some pitchers returning to play with increased pitch velocity, Tommy John Surgery has rapidly become a common procedure in baseball of all levels, not only the professional ranks.

Baseball pitching injuries among youth athletes are an increasingly serious concern amongst parents, coaches, and medical professionals owing to the large number of these injuries occurring each year. "Epidemiologic studies of American youth and high school players have found an incidence of elbow pain between 26% among youth players and 58% among high school players.[7]" Dr. James Andrews, a researcher in the area of the UCL, has performed more Tommy John surgeries than anyone in the world. He estimates that about 20% of his UCL patients were major leaguers, and another 20%-25% were minor league professionals, but that the majority have been college or high school athletes[10]. Most of these athletes were injured in their junior or senior years of high school, making development for college or amateur careers difficult and limiting their opportunities to play baseball after recovery. In the late 1990s very few of the ulnar collateral ligament reconstructions performed were for youth or high school pitchers. However, rates in youth and high school–age pitchers have risen to approximately one-fourth of these surgeries in the 21st century. As R.K. Rahman puts it, "Advances in [UCL] prevention strategies, particularly in the young athlete, are needed as this injury is being observed in the young athlete at an alarming rate.[4]" Furthermore, the popularity of organized youth baseball makes our understanding of injuries in this population paramount from a public health standpoint.

Current Methods

Injury to the ulnar collateral ligament (UCL) of the elbow causes significant disability in the throwing athlete. The most significant symptom is medial elbow pain. It is occasionally accompanied by ulnar nerve paresthesias. Throwers usually notice a decrement in their velocity and/or control. In high school baseball, most UCL injuries become apparent in a single throw, in which a popping or tearing sensation in the elbow is accompanied by immediate medial elbow pain. The microtrauma leading up to this injury, however, is usually accumulated over an entire season or career.

"History and physical examination remain the cornerstones of diagnosis of ulnar collateral ligament insufficiency in the throwing athlete.[28]" Physical exam features suggesting MCL injury include point tenderness directly over the UCL or at the insertion sites. Several orthopedic tests exist to identify UCL injury yet only a select few are consistently mentioned in the research. "Valgus instability is tested with the patients' elbow flexed between 20° and 30° to unlock the olecranon from it's fossa as valgus stress is applied.[4]" Then with the patient's forearm supinated and elbow flexed beyond 90°, the milking maneuver is performed by pulling on the patient's thumb to create valgus stress. The moving valgus stress test (MVST) is also commonly used. "The MVST is a modification of the milking maneuver where valgus stress is applied while the elbow is moved through an arc of flexion and extension.[4]" With either test, a positive finding is the feeling of apprehension, instability, or localized pain. This indicates UCL injury. Physical exam should also assess to what degree of extension is lost. The ulnar nerve should be palpated for possible subluxation and Tinel's sign at the elbow should be elicited. The most significant physical examination finding is pain with a valgus force placed across the joint in the arc of motion between 60° and 120° of elbow flexion (positive dynamic valgus stress test). This sign was present in all operative candidates in study conducted by Petty, Fleisig, and Andrews[11]. Once UCL insufficiency has been diagnosed, surgical repair or reconstruction is usually next step in treatment. In cases of anticipated reconstruction, the presence of a palmaris longus should be ascertained for the grafting techniques involved in reconstruction.

Ulnar collateral ligament reconstruction, widely known as Tommy John Surgery, hasn't changed much since it was pioneered. Orthopedist Frank Jobe first performed the procedure on LA Dodgers pitcher, Tommy John in September of 1974. The procedure calls for removal of a tendon from the patient's wrist or hamstring, which is grafted into the elbow (autograft) — weaved in a figure-eight pattern through tunnels drilled in the humerus and ulna bones[10]. This is better known today as "the docking technique."

The initial technique described by Jobe and colleagues[3] reported a figure-of-8 graft fixation technique with humeral tunnels placed posteriorly. In this technique, the autograft is placed through 2 drill holes in the ulna and 3 in the medial epicondyle in a figure-of-8 fashion, with the posterior cortex of the humerus penetrated and the graft sutured to itself. In "the docking technique," "the ulnar tunnels are created in the same manner as in the Jobe technique but the humeral tunnels are created with a single inferior tunnel and two small superior and anterior exit tunnels. The graft is delivered into the inferior tunnel and tensioned with sutures that exit the superior tunnels and fixation is achieved by tying the sutures over a bone bridge." While a variety of autografts are used to perform modern Tommy John Surgery, the most commonly used are the ipsilateral or contralateral palmaris longus tendon autograft.

The surgery requires a full year of rehabilitation and typically another year of pitching before returning to pre-injury form. Essentially, the body must get the tendon carrying blood again and train it to start working as a ligament. It is very weak immediately after the surgery, and the rebuilding process must be gradual[10].

The current rehab regimen for UCL reconstructive surgery varies from team to team, doctor to doctor and with the patient's progress, however this is the basic schedule as outlined by Kevin E. Wilk, national director of research and clinical education for the HealthSouth Sports Medicine & Rehabilitation Center:

• First five to seven days — Elbow immobilized at 90 degrees in a hard brace. Patients can move the hand and start light gripping exercises immediately.

• Second week — Arm is in an adjustable brace that allows limited movement. Patients can begin everyday movements, such as using the arm to eat. Elbow extension is gradually increased, and the brace can be eliminated at four to six weeks.

• Weeks three to eight — Emphasis on range of motion exercises for the elbow, plus isometric and light weights (dumbbells) for the shoulder. Heavier resistance to elbow work added at about eight weeks.

• 10 weeks — Simulating a throwing-type motion with a medicine ball, making two-hand overhead lobs and chest passes.

• 12 weeks — Can start to swing a golf club.

• 12 to 14 weeks — One-hand throwing motion with a 1-pound medicine ball "to get the tissue used to these applied forces," Wilk says.

• 16 weeks — Begin throwing program. Start on flat ground, with soft tosses from about 45 feet. About 25 tosses, rest, then 25 more. End workout. Throw every other day; distance and repetitions are repeated two or three workouts before being increased. Build to 150 to 180 feet.

• Four to five months — Bowling permitted, slowly.

• Six months — Begin to throw off mound. Start at about 50% speed/effort — no curveballs or specialty pitches — and gradually increase the number of pitches and intensity.

• Seven months — Start throwing breaking balls, first from short distances on flat ground and with little torque. Build up intensity and distance gradually.

• Eight to 10 months — Introduction to game conditions: batting practice, then a simulated game, then game at a lower level.

• Eleven to 12 months — Return to competition. It often takes a full season of action before the pitcher returns to pre-surgery effectiveness.[10]

Rehabilitation of UCL reconstruction involves dedication to the exercises and adherence to the rehab schedule. As Wilk points out, "It often takes a full season of action before the pitcher returns to pre-surgery effectiveness." This means, from the date of surgical repair, a pitcher should expect 2 full seasons to pass before they throw the ball with pre-injury success. This is especially significant when discussing younger athletes. In a 2004 study conducted by Petty, Andrews, and Fleisig, it was demonstrated that 15% of participants abandoned their rehabilitation and lost interest in baseball owing to graduation or pursuing other interests.

Prevention

"The high incidence of elbow injuries that occurs among baseball pitchers has been presumably linked to the bending moment induced during throwing that places the elbow joint under excessive valgus loads[12]." In 2008, Dun et al. identified four potential risk factors for pitching injury. They stated that the number of pitches thrown (during a game/season), the type of pitches (e.g. curveball), the pitcher's mechanics while throwing, and the physical condition of the pitcher could all result in excess force being exerted into the medial elbow[7]. Physical conditioning of each pitcher is an obvious and widely variable risk factor and will be excluded from this review.

Pitch Counts

The risk factor with the strongest correlation to injury is amount of pitching. Many injured high school baseball players describe regimens that include year-round throwing, with bullpen work or long-toss programs throughout the off-season. Others describe excessive throwing during the regular season, a playoff, or a showcase event. "The overuse-type throwing habits seen in these pitchers induce substantial, repeated microtrauma to the static restraints of the throwing elbow, without offering adequate time for healing. Accumulation of this microtrauma leads to a cumulative overload of the UCL. As a result, this tissue becomes weakened and prone to catastrophic failure.[11]" A 2012 study by Ahmad et al., surveying the public perception of Tommy John Surgery, shows that high pitch counts are the most consistently identified risk factor for UCL injury by the athletes themselves (youth, 51%; high school, 79%; collegiate, 82%), coaches (69%), and parents (75%)[15]. Lyman et al [25] and others have demonstrated that there is a significant association between the number of pitches thrown in a game and during the season and the rate of elbow pain. The influx of data regarding the negative effects of overuse have prompted The USA Baseball Medical & Safety Advisory Committee (USABMSAC) to put in place guidelines to establish age appropriate in-game pitch limits [Table 1, right]. The implementation of these limits would reduce the number of overuse injuries across all levels of baseball.

Age, y	Max Pitches per game	Max games per week
8-10	50	2
11-12	65	2
13-14	75	2
15-16	90	2
17-18	105	2

Pitch Types

The type of pitch thrown can also be a risk factor. Numerous biomechanical studies have been conducted to investigate the mechanical difference between pitch types. Elliott and Grove[26] compared the motion of the fastball and curveball. They used a 3-dimensional cinematographic system to document the kinematic differences between the two pitches. They reported minor differences in stride length and forearm action before ball release and wrist action after ball release. Using the same technology, Sakurai et al[27] demonstrated similar results. More pitch types were included (change-up and slider) were included in the kinematic comparison. The authors found that the motions of the fastball and slider were similar. The curveball had more forearm supination, less wrist extension, and a shorter stride than the fastball and change-up. They also reported that the curveball showed the slowest trunk rotation.

Studies have reported that professional pitchers who rotate later in the pitching cycle generate more internal rotation torque at the shoulder than do those who rotate earlier[13]. Given that elbow valgus stress is significantly correlated with shoulder rotation torque[14], it can be hypothesized that the onset of trunk rotation would subsequently influence elbow valgus torque[12]. As Aguinaldo and Chambers concluded, "Elbow valgus

torque is most influenced by maximum shoulder external rotation, elbow flexion at peak valgus load, elbow flexion at ball release, timing of maximum elbow flexion, onset of trunk rotation before ball release, and elbow valgus loading rate[12]." These kinematic and kinetic patterns reinforce previously published findings indicating that elbow valgus torque is closely related to angular mechanics at the shoulder and elbow during pitching. Therefore, throwing a curveball slows trunk rotation, which subsequently creates "arm lag," increasing the valgus forces directed into the medial elbow.

Pitch Type[11]	Age
Fastball	8
Change-Up	10
Curveball	14
Knuckleball	15
Slider	16
Forkball	16
Splitter	16
Screwball	17

Research of this kind combined with established knowledge of skeletal growth patterns has also prompted the USBMSAC to establish guidelines for coaches, parents and athletes to follow regarding pitch types [Table 2, left]. These guidelines are suggested with an understanding of skeletal growth and ossification patterns. As Klingele and Kocher state, "There are six secondary ossification centers present in the developing elbow, each with a predictable ossification rate." "The medial epicondylar epiphysis is usually the last center to fuse, around 15-16 years of age.[9]" They conclude that, "Proper throwing mechanics must be emphasized at an early age, and the determinants of elbow injury among young pitchers better understood. Early recognition and proper treatment of such injuries will then prevent later sequelae or functional disability.[9]"

Pitching Biomechanics

Although pitch counts and pitch types are easily identifiable risk factors they have taken a back seat in the research world to pitch mechanics. In non-allopathic professions, such as chiropractic and physical therapy, focus is placed on correcting flaws in the pitchers throwing mechanics to prevent such excessive loads. This is most easily examined with 3-dimensional motion analysis. Researchers most often place reflective tabs at key points in the kinetic chain and film the athlete with a high-speed camera. The researcher is then able to breakdown the phases of pitching frame-by-frame, finding flaws in a pitcher's delivery.

Most delivery problems begin below the waist. It is widely believed that the most telling moment in a pitcher's delivery is the foot strike. This is when the lead foot makes contact with the mound and marks the beginning of the late cocking phase. Correct mechanics call for the pitching arm to be up and ready to throw at the instant of foot strike. During that instant, a right-handed pitcher should be showing the baseball to the shortstop, a lefty to the second baseman. If at the moment of foot strike, a pitcher's elbows come higher than his wrists and shoulders with the ball pointing down, he's said to be demonstrating an "inverted W" [Figure 3]. The "inverted W" is a hallmark sign that a pitcher's sequencing is off and is often considered a predictor of future Tommy John recipients. Such poor timing leads to arm lag, evident when the throwing elbow trails the shoulder once the shoulders square to home plate. Current major league pitcher and Tommy John surgery recipient, Adam Wainwright [pictured below] exhibits both problems.

Figure 3 - MLB Pitcher Adam Wainwright demonstrating the "inverted W"

This forces him and others like him to rely more on the arm's relatively small muscles instead of the more massive ones in the legs and torso. Throw after throw the shoulder and elbow are under extra stress. The higher the pitch's velocity, the worse the flaw becomes and the more the arm suffers. In addition, the more a pitcher throws, the worse the injury becomes.

"Determining the biomechanical patterns that place the elbow at high risk may lead to coaching and training methods designed to correct inefficient pitching mechanics that lead to high valgus loads.[12]" Educating and training coaches to identify and correct the "inverted W" could lead to a tremendous decrease in the amount of UCL injuries occurring, especially in youth baseball players. Ahmad polled high school players that had undergone Tommy John Surgery about the role of coaches. The poll found that they were often late to intervene, reducing the amount of throwing done by these athletes only after significant symptoms were present. Only 52% of injured players thought that their coaches were careful about preventing throwing injuries.[15]

Public Education

Reported success with UCL reconstruction, defined as a patient being able to return to his previous level of pitching, ranges between 80% and 92%. Many famous professional baseball pitchers have undergone the procedure and have returned to competition with outstanding performance. Ulnar collateral ligament reconstructive surgery has thus become a well-known operation to baseball spectators and young players. Unfortunately, the public eye is only drawn to cases of success, not the many players whose careers have ended because of the procedure. In turn, sports physicians are seeing an "increase in the number of uninjured young throwers presenting with their parents for medical evaluation, seeking UCL reconstructive surgery with the hopes that it will improve their performance despite a lack of symptoms.[15]" Additionally, these players and families often do not understand factors that cause the injury or the required postoperative rehabilitation.[15]

In 2012, Ahmad, Grantham, and Griewe conducted a study to assess the public perception of Tommy John Surgery. A simple questionnaire was created to determine the public perception of UCL injury and surgical reconstruction. Topics addressed by the survey included exact indications, risks and benefits, operative technique, and recovery time. In addition, factors potentially associated with injury, such as number of pitches and types of pitches thrown were also included. They surveyed 260 participants, which consisted of 53 youth players, 53 high school players, 83 collegiate players, as well as 15 coaches and 36 parents. They concluded that players, coaches, and parents all underestimated the athlete's ability to return to sport with non-operative treatments. The results revealed that 30% of coaches, 37% of parents, 51% of high school athletes, and 26% of collegiate athletes believed UCL reconstruction should be performed on players without elbow injury to enhance performance.

They also found that another major misperception of the public is the amount of time and rehabilitation required to recover from Tommy John surgery. Published reports indicate that return to competition is generally ≥ 12 months for pitchers, however every group in Ahmad's study underestimated the required time for rehabilitation.

Non-operative patients have an overall rate of return of 42%, according to Rettig et al[28]. This may give the athlete some hope of returning without undergoing surgical treatment and the year long rehab program that accompanies it. The average timeframe from diagnosis to return amongst non-operative patient was 24 weeks, much less than the time required after UCL reconstruction[28]. This may be even more significant for youth pitchers. Dr. James Andrew states, "These young athletes are also better able to heal injuries than the older athlete, so conservative treatment has a higher chance of being effective[11]." Thus, the benefits of conservative care and risks of reconstructive surgery should be explained thoroughly to all players, parents, and most importantly, coaches. "Because of the popularity of youth baseball and the potential for injury, there is a need for pitching instruction that combines the scientific validity of the motion analysis laboratory and the ease of use of an on-field video camera.[30]"

Conclusion

Ulnar Collateral Ligament injury and the reconstructive surgery that tends to accompany it have become commonplace in overhead throwing athletes. Currently, 1 in 9 Major League Baseball pitchers has undergone Tommy John Surgery at some point in his career. The high costs and lengthy rehabilitation associated with the procedure are resulting in some players not returning to the sport. While medical procedures of diagnosis and treatment are very successful, a prevention-centered paradigm would save families and teams a lot of money and keep up to 22% of athletes in the sport[15]. Public education, limiting pitch counts, limiting pitch types, and biomechanical analysis used in combination will drastically decrease the number of athletes undergoing Tommy John Surgery.

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